DIY Kit 20. CRYSTAL-LOCKED ULTRASONIC MOVEMENT DETECTOR

25090

INTRODUCTION

You will find many uses for this movement detector. It is built around a matched pair of ceramic transducers which convert movement energy to electrical energy and vice versa. The operating frequency of the pair is 40 kHz. Any movement in the area scanned by the transducers will be detected and a pulse produced. In this Kit the pulse turns on an LED. Pads are provided to take this pulse to add-on circuits where it may be used to turn on buzzers, lights etc. A PCB-mounted switch can be used to switch between an automatic reset about 0.3 seconds after the detector has been triggered or to stay latched on. The unit will reliably work from four meters to over 8 m depending on the sensitivity setting and the direction of the movement.

The kit is constructed on a single-sided printed circuit board (PCB). Protel Autotrax and Schematic were used to design the board.

ASSEMBLY INSTRUCTIONS

1. The most important thing is to make sure the ultrasonic Transmitter (Tx) and Receiver (Rx) units are put into their correct positions on the small circuit board. If they are mixed up then damage to the receiver unit will probably result. The transmitter is marked with a 'T'. The receiver is marked with an 'R'. To make soldering easier (and not heat the Tx/Rx units) gently scrape the legs of each transducer before soldering.

2. Make sure to connect the earth/case Rx sensor pin (it is the pin which is connected to the metal case) to the earth pad of the 'TO RECEIVER' pads on the main circuit board. The earth pad is marked with an **E**. The polarity of the Tx unit is not important in this circuit. It can be connected either way around.

3. The circuit is very sensitive. Separate the two pairs of wires going to the two ultrasonic units to prevent electrical crosstalk between them. If you want to locate the units more than 1-2 feet from the PCB then you should use coaxial cable to shield the two transducers.

With these points to keep in mind assembly is straight forward and components may be added to the PCB in any order. Generally it is best to solder the lowest height components first such as the resistors and IC sockets. Then move onto the physically taller components. Note in particular the polarity of the electrolytic capacitors, the IC's and the diodes. As mentioned clean the legs of the Tx & Rx units so soldering is quick and easy. Do not overheat the ultrasonic units during soldering.

CIRCUIT DESCRIPTION

Transmitter. A crystal-locked cmos gate oscillator feeds a 40kHz square wave to a cmos driver which is connected to drive the transmitter in anti-phase to get the maximum output.

Receiver. The electrical signals detected are amplified by transistor T3. They are further amplified by the op-amp IC1 which also references the negative peaks of the signal to a predetermined DC level. The output of IC1 is converted to DC in a peak detector and then taken to the non-inverting input of IC2. The feedback circuit on this op-amp can be adjusted by the sensitivity potentiometer to control the amplifiers sensitivity. If there is no change in incoming signal level IC2 quickly adjusts to a steady high output.

Sound waves reflected by different objects arrive at the receiver in different phases. If they are in phase they add to create a larger signal. If they are out of phase they cancel to give a smaller signal. As an object moves towards or away from the Receiver unit by a small distance (about 1 cm) it causes the receiver signal to cycle through a high/low cycle. It is this change from in-phase to out-of-phase which triggers the unit. The steady high output of IC2 is pulled down causing the cmos gates of IC3 to switch. They are arranged in a schmidt trigger configuration. The high on pin 4 turns on the Darlington arrangement of transistors which turns on the LED.

This output signal is available at Pads 1 and 2 where it can be taken to triger other devices such as relays, buzzers opto-couplers etc. Small DC loads (up to 50mA) can be directly connected to Pads 1 & 2. An opto-coupler (eg, MOC3021) can be directly connected to the pads.

Calibration. No calibration is needed since the crystal oscillator circuit resonates at 40kHz which is the optimum frequency of the transducers. The Sensitivity control is the only control to be adjusted to suit your purpose.

Each unit best transmits and receives in a 40 degree cone spreading out from each unit. Naturally in the area to be monitored these imaginary cones must overlap - you cannot have the Tx unit pointing one way and the Rx unit pointing the other! You may cut the circuit board holding the Tx/Rx units and separate them further apart.

WHAT TO DO IF IT DOES NOT WORK

Poor soldering is the most likely reason that the circuit does not work. Check all solder joints carefully under a good light. Next check that all components are in their correct position on the PCB especially diodes, electrolytic capacitors, and IC's. If you put in the Tx/Rx around the wrong way they may have been damaged.

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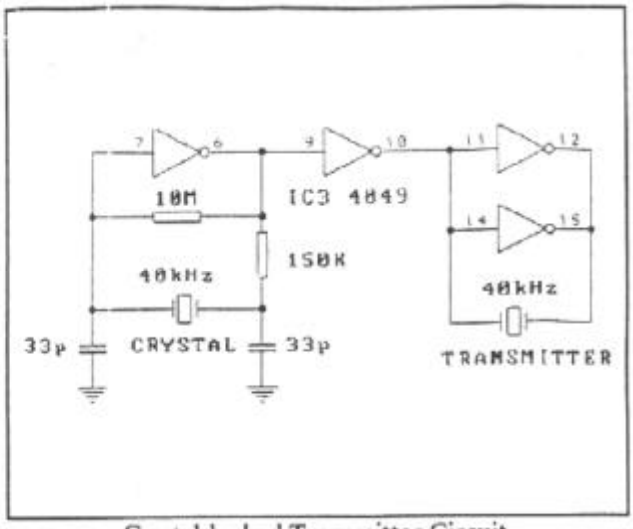
COMPONENT LISTING:

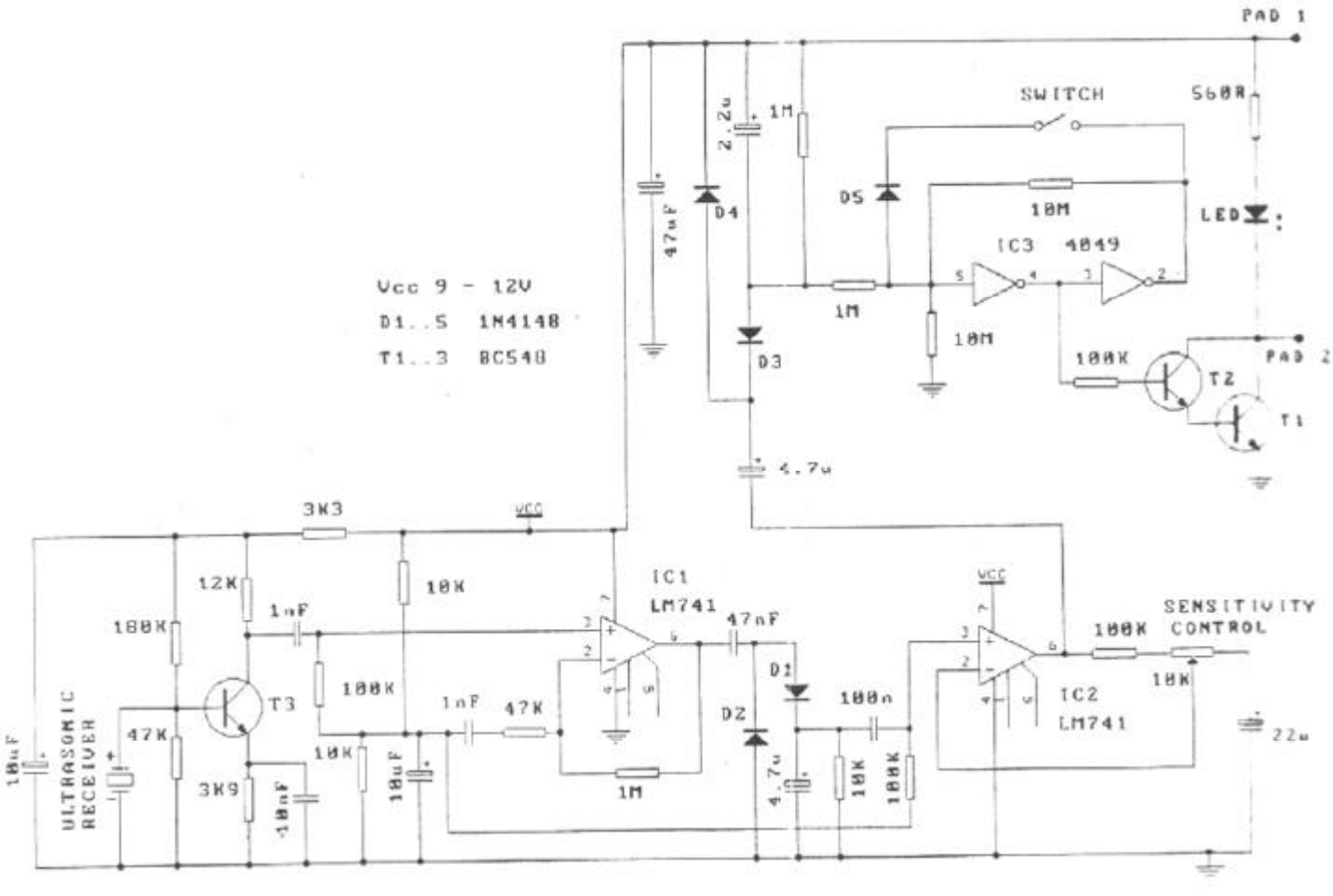
Resistors carbon film 1/4W, 5%.

100K	4
10K	3
1M	3
10M	3
47K	2
3K3	1
180K	1
150K	1
12K	1
3K9	1
560R	1
10K potentiometer	1
Diode 1N4148	5
LED 5mm	1
SPDT PCB switch	1
LM741 IC	2
14049/4049 IC	1
16 pin IC socket	1
8 pin IC socket	2
Capacitors:	
33pF ceramic	2
1nF mylar	2
10nF mylar	1
47nF mylar	1
100nF mylar	1
4.7uF electrolytic	2
10uF "	2
2.2uF "	1
22uF "	1
47uF "	1



Crystal-locked Transmitter Circuit.

BC548	3
40kHz crystal	1
9V battery snap	1
Ultrasonic transmitter	1
Ultrasonic receiver	1
Kit 20 PCB	2 pieces
4 strand flat cable	6"
Documents	1 page



Receiver Circuit